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by

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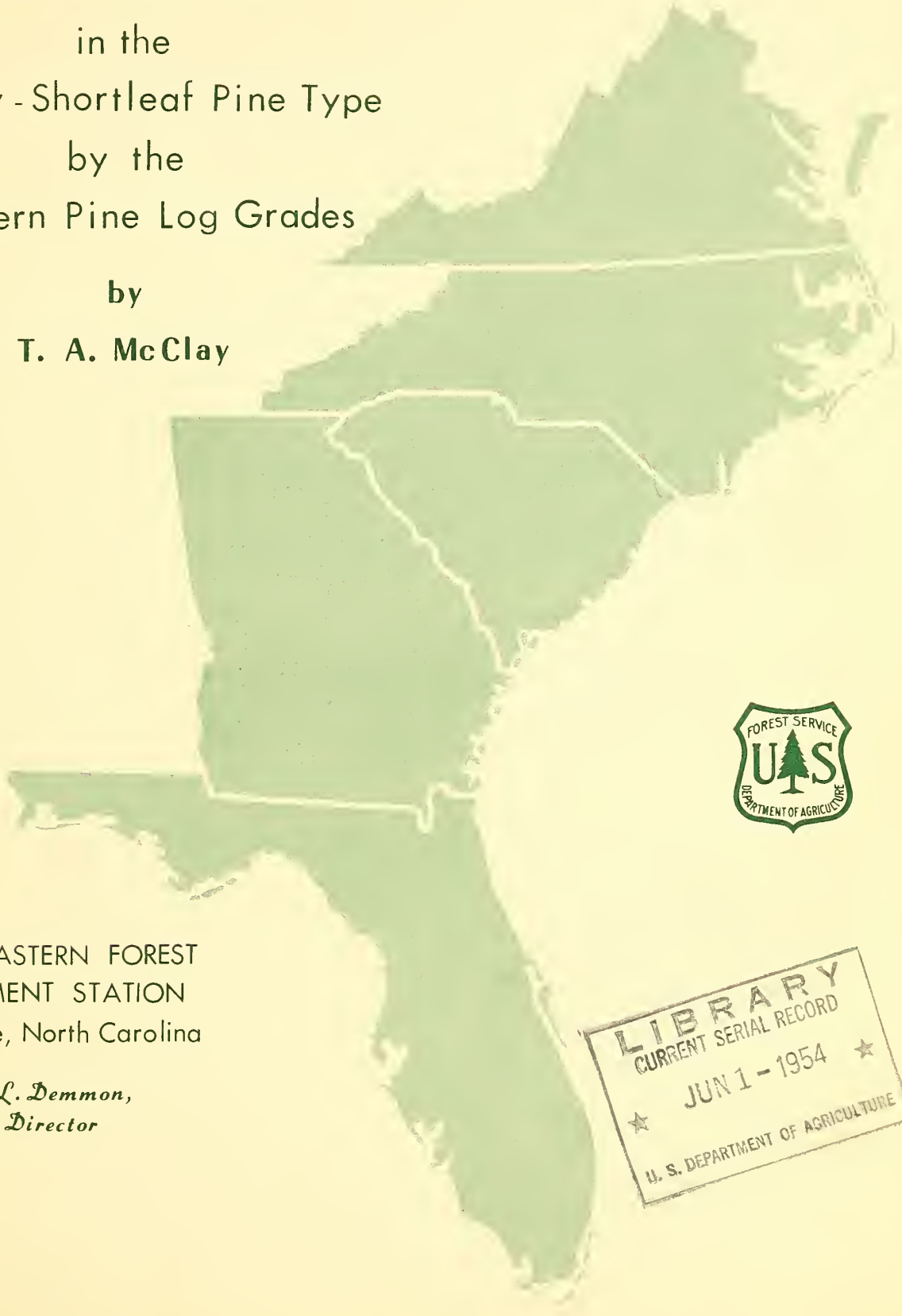

SOUTHEASTERN FOREST
EXPERIMENT STATION
Asheville, North Carolina

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LUMBER GRADE YIELDS IN THE LOBLOLLY-SHORTLEAF PINE TYPE BY THE SOUTHERN PINE LOG GRADES

by

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The U. S. Forest Service has recently developed a system of grading all southern pine logs being sawed into standard yard lumber. This log grading system provides a means by which the quality of southern pine logs as expressed by yard lumber grade recovery or dollar value per thousand board feet may be estimated. The research techniques used in developing the log grades show that these grades will stratify pine logs into value groups more accurately than any other existing set of log grades. With the completion of the research phase of log grade development, the job now is to determine lumber grade yields by log grade under varying local conditions.1/

The purpose of this paper is to present lumber grade percentage recoveries and relative values obtained when applying this log grading system at two separate localities in the loblolly-shortleaf pine type. A publication which discusses more fully the technical derivation, use, and interpretation of the log grades has been prepared by the Southern Forest Experiment Station2/ and may be obtained upon request.

DEFINITIONS AND SPECIFICATIONS OF THE LOG GRADES

The basic criterion for determining the grade of a log by this system is the diameter inside bark at the small end and its relation to the number, size, and type of knots present (fig. 1). Thus, a large-diameter log free of knots would be of the highest grade, while a small-diameter log with many knots would be of the lowest grade. Various combinations of diameter and knots would place logs somewhere between these two quality extremes. Sweep, wood-rot fruiting bodies, and excessive dispersion of large or unsound knots are secondary factors in further defining the grade of a given log. Detailed definitions and specifications of these interim log grades for southern pine are shown in (fig. 2).

1/ Until this phase of field testing has been completed, the log grades are designated as Interim U. S. Forest Service Standard Grades.

2/ U. S. Forest Service. Interim log grades for Southern pine. Southern Forest Experiment Station, New Orleans, La. 1953.

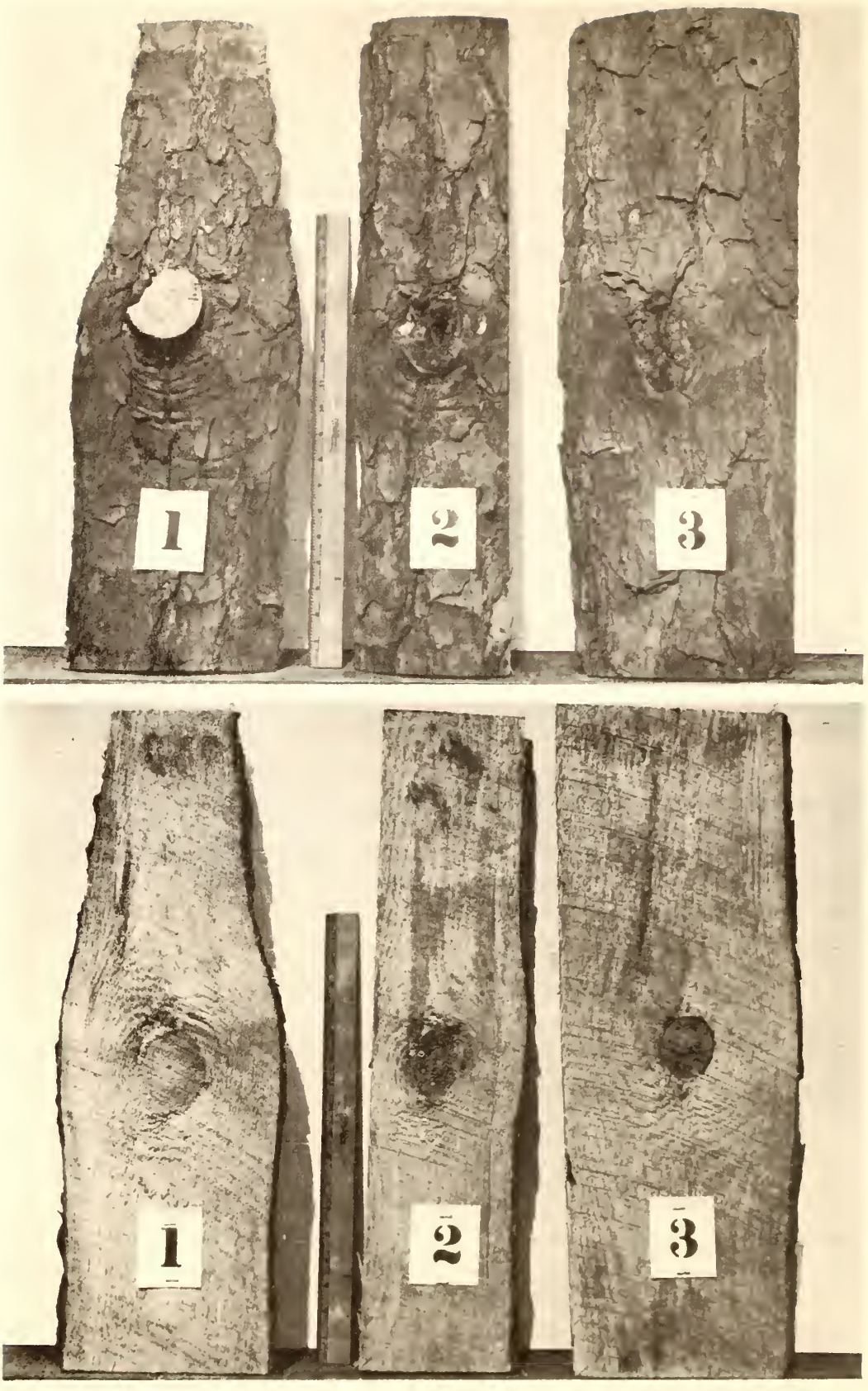


Figure 1.--Knots in conjunction with log size are the primary factors in determining log grade. Slab views show: (1) 3-inch sound knot; (2) and (3) 2-inch overgrown knots in two stages of development. Any knot is unsound if it contains advance decay extending to log heart or a hole larger than 1/4 inch penetrating more than 2 inches.

INTERIM LOG GRADES FOR SOUTHERN PINE

(Based on unit value of yard lumber outturn)

Log	Any approximately cylindrical tree section. Common usage excludes pieces with length less than 8 feet or with average scaling diameter inside bark at small end smaller than 4-1/2 inches. Logs longer than 20 feet are beyond the scope of this table unless graded as several shorter logs.
Face	Any quarter-cylindrical surface running full log length.
Overgrown knot	Any invisible branch or stub buried beneath the log surface but indicated by a surface bump or disturbance of bark pattern.
Sound knot	Any visible branch, stub, or socket which contains neither advance decay extending to log heart nor any hole larger than 1/4 inch penetrating more than 2 inches (excludes defects defined in 1948 SPIB Rules paragraph 12d and 12e).
Unsound knot	Any visible branch, stub, or socket not conforming to definition of sound knot.
D	Average diameter of log inside bark at small end to nearest whole inch.
K	Number of overgrown knots plus sum of diameters of sound knots plus twice sum of diameters of unsound knots. Average diameter of knots should be measured to nearest whole inch at point where limb would normally be trimmed.
Sweep	Greatest deviation of longitudinal log axis from straight line connecting centers of each end of log. It should be measured to nearest whole inch, and is analogous to the middle ordinate of an arc.
Bad knot	Any visible knot which is so large that D is less than 6 times knot diameter, or any unsound knot.

Interim Southern Pine Yard Lumber Log Grade Criteria

Log grade	Minimum diameter and maximum aggregate knot criteria		
	With 4 visible faces	With 3 visible faces	With 2 visible faces
1	$D \geq 17$ and $5K \leq D$	$D \geq 17$ and $7K \leq D$	$D \geq 17$ and $10K \leq D$
2	$D \geq 10$ and $2K \leq D < 5K$	$D \geq 10$ and $3K \leq D < 7K$	$D \geq 10$ and $4K \leq D < 10K$
3	$D \geq 5$ and $D < 2K$	$D \geq 5$ and $D < 3K$	$D \geq 5$ and $D < 4K$
4	$D \geq 5$, but not qualified for higher grade after compliance with following degrade rules:		

(A) Degrade any log one grade if D equals or is less than 3 times sweep of at least 3 inches.

(B) Then degrade any non-Grade 4 log one grade if massed heart-rot hyphae visible on circumferential log surface suggest that fruiting has occurred or is imminent.

(C) Then degrade any Grade 3 log to Grade 4 if "bad knots" are too dispersed for containment in a 90 degree radial sector extending 1/4 of log length.

Figure 2.--All factors that go to make up the complete log grading system are shown above. Simplified guides and short cuts may be obtained from the Southeastern Forest Experiment Station, P. O. Box 2570, Asheville, N. C.

Under any system of log grading which separates logs into distinct and independent quality classes, there may be some misclassification of those logs which fall in the borderline zone between grades. The possibility of such misclassification is least when logs are graded by an examination of four faces. However, it is often impossible to see all faces, as in a deck of logs; or it may be inconvenient to turn each individual log while grading. This difficulty can be overcome by grading on the basis of two or three faces. If the grader is unbiased and does not consistently favor either the best or worst faces on the logs, a satisfactory estimate of quality can be obtained in most cases. Accuracy of quality prediction is least when grading a small group of logs such as a truckload, and greatest when applied to a large group of logs such as a day's run. In the southern Piedmont study, which consisted of 427 logs, there was practically no difference in log quality index by log grade when grading by either two, three, or four faces. Grading logs on a 3-face basis appears to offer the best combination of accuracy and practical application.

LUMBER GRADE YIELDS

Grade-yield studies applying the log grades in the loblolly-shortleaf pine type have been made in two localities--the Coastal Plain of South Carolina and the southern Piedmont of Georgia. In each case the sawmill was a conventional circular mill of the portable type equipped with an edger. Lumber grading was done on the green chain by a company grader or a representative of the Southern Pine Inspection Bureau. The mills sawed for grade and whenever the unit value of a board could be increased by theoretical end trimming, the grader did so.

The lumber grade percentage recovery by log d.i.b. and grade for each of the mill-scale studies is shown in tables 1 and 2 and in graphic form in figures 3 and 4. The percentages are average figures taken from smoothed curves and are based on rough green lumber tally. Although the logs were a mixture of shortleaf and loblolly pine, a large majority were of the latter species. The grade yields are based on 861 logs in the Coastal Plain and 427 logs in the southern Piedmont. Four additional logs in each study were not included since they occurred singly in d.i.b.-grade categories at the extremes of the range.

The generally higher grade yields shown in table 2 for the southern Piedmont as compared to those shown in table 1 for the Coastal Plain are due in part to the nature of the timber stand from which the logs were cut. The southern Piedmont timber was of old-field origin and consisted largely of residual small trees which had been left after logging in the 1920's. These well-pruned trees had grown to sawtimber size by the time of cutting. The Coastal Plain timber was forest grown and the logs came from an improvement cut consisting mainly of understory trees, poor risks, and rough dominants. In addition, almost all of the grade-2 logs in the southern Piedmont were butt logs as compared to only two-thirds of the Coastal Plain grade-2 logs. Although lumber grade yield from a Coastal Plain grade-2 butt would be slightly higher than the average shown for grade-2 logs in table 1, it would not be as high as a southern Piedmont grade-2 butt because of the added effect of early pruning inherent in the latter.

These differences indicate the desirability for mills to make a simple grade-yield study for the general run of timber in their locality and under their particular manufacturing conditions. Such a study would provide local, on-the-spot grade recoveries which are more applicable locally than table values obtained elsewhere.

BOARD WIDTHS BY LOG DIAMETER

A large-diameter log of a given grade has a greater value per board foot than a small-diameter log of the same grade, because of the wider boards obtainable from the large log. Both of the circular mills used in this study produced similar board-width yields from logs of a given diameter. The percentages of board widths produced by logs of different diameter and based on average values for smoothed curves are shown in table 3 and figure 5.

Although the value of a log or group of logs can be estimated from the percentage recovery in tables 1, 2, 3, the procedure is cumbersome. Log value may be more easily obtained through the use of a log quality index which expresses grade and width recovery in a single number. The index is based upon the fact that while lumber markets fluctuate widely, the values of different grades of lumber tend to remain in constant ratio to one another. Thus, in the present study, boards of No. 2 Common, standard length, 1 x 8, kiln dried, S4S, were assigned a lumber value index of 100. Higher grades and greater widths have indices greater than 100; lower grades and narrower boards have lower indices. The quality index of a log is obtained by multiplying the board volume of each lumber item by its lumber value index and dividing the sum of these weighted values by the total lumber tally of the log.

LOG QUALITY INDICES

A log quality index so obtained thus represents the average value per thousand board feet of dry lumber from the log and is based on the price of No. 2 Common 8-inch boards. For example, if a log had a quality index of 110, and the No. 2 Common price was $80.00 per MBM, the lumber yielded from the log would have an estimated value of (110 x .80), or $88.00 per MBM f.o.b. car. Log quality indices from each of the grade yield studies are shown in table 4 and figure 6. These indices were computed from basic data comprising tables 1, 2, and 3, and represent average values from smoothed curves.

It would not be necessary to use the individual quality index given for each log d.i.b. and grade unless the utilized logs tended to be spread over a wide size-range within grade and with an uneven distribution. A more practical use of quality index would be to estimate the average diameter within grade of the usual run of logs and use the quality index of that log diameter.

Table 1.--Average percentage yard lumber grade recovery by log diameters and grades--loblolly-shortleaf pine type in the central Atlantic Coastal Plain near Charleston, S. C.

Log d.i.b. (inches)	Log grade 1						Log grade 2					
	Lumber grade					Basis	Lumber grade					Basis
	B&Btr	C	1C	2C	3C		B&Btr	C	1C	2C	3C	
	Percent of rough green					Number of logs	Percent of rough green					Number of logs
10	--	--	--	--	--	--	20	16	34	28	2	7
11	--	--	--	--	--	--	25	18	32	23	2	10
12	--	--	--	--	--	--	29	19	31	19	2	14
13	--	--	--	--	--	--	31	21	31	15	2	14
14	--	--	--	--	--	--	33	22	31	12	2	23
15	--	--	--	--	--	--	33	23	31	11	2	17
16	--	--	--	--	--	--	33	24	31	11	1	26
17	45	20	29	6	--	8	33	24	32	11	--	7
18	47	22	27	4	--	18	32	24	33	11	--	13
19	50	24	24	2	--	9	31	23	35	11	--	4
20	53	25	21	1	--	11	30	22	36	12	--	2
21	56	26	18	--	--	3	29	21	38	12	--	0
22	59	27	14	--	--	3	28	19	40	13	--	3
Average	51	24	23	2			31	21	34	14		
	Log grade 3						Log grade 4					
6	3	7	46	44	--	0	--	--	6	94	--	0
7	5	7	44	44	--	2	--	--	7	92	1	25
8	7	8	41	44	--	4	--	1	8	88	3	52
9	8	8	38	45	1	12	--	2	9	85	4	62
10	9	9	36	45	1	16	1	2	9	83	5	92
11	10	9	34	46	1	9	2	2	9	80	7	73
12	11	10	32	46	1	22	2	2	9	78	9	59
13	12	10	30	47	1	32	1	3	8	78	10	32
14	12	11	28	48	1	21	1	3	8	77	11	39
15	13	11	27	48	1	22	1	3	8	77	11	28
16	14	11	26	48	1	20	1	4	7	77	11	16
17	14	12	24	48	2	8	--	5	6	78	11	8
18	15	12	23	48	2	7	--	5	5	79	11	0
19	16	12	21	48	3	3	--	5	4	80	11	5
20	16	12	19	49	3	0	--	5	4	80	11	0
Average	13	10	29	47	1		1	3	8	80	8	

Table 2.--Average percentage yard lumber grade recovery by log diameters and grades--loblolly-shortleaf pine type in the southern Piedmont near Macon, Georgia

Log d.i.b. (inches)	Log grade 1 1/						Log grade 2					
	Lumber grade					Basis	Lumber grade					Basis
	B&Btr	C	1C	2C	3C		B&Btr	C	1C	2C	3C	
	Percent of rough green					Number of logs	Percent of rough green					Number of logs
10	--	--	--	--	--	--	45	20	34	1	--	9
11	--	--	--	--	--	--	47	19	31	3	--	16
12	--	--	--	--	--	--	49	18	28	5	--	15
13	--	--	--	--	--	--	51	16	26	6	1	15
14	--	--	--	--	--	--	53	15	23	7	2	9
15	--	--	--	--	--	--	55	14	21	8	2	5
16	--	--	--	--	--	--	56	13	20	9	2	4
Average							50	18	26	5	1	
	Log grade 3						Log grade 4					
6	1	2	69	28	--	4	--	--	38	56	6	4
7	5	5	60	30	--	12	--	1	34	60	5	27
8	9	8	52	31	--	18	2	3	29	62	4	51
9	12	9	46	32	1	19	3	4	26	64	3	48
10	14	10	40	34	2	26	4	5	23	65	3	25
11	16	11	35	36	2	16	5	5	21	67	2	30
12	18	12	30	37	3	23	6	6	20	67	1	5
13	18	13	28	38	3	13	6	6	19	68	1	8
14	19	13	25	39	4	13	6	6	19	68	1	3
15	19	14	24	39	4	7	6	6	18	69	1	0
16	20	15	22	39	4	2	6	6	18	69	1	0
Average	17	12	35	34	2		4	4	25	64	3	

1/ None of the logs in the southern Piedmont study was large enough to meet the diameter requirements for grade 1 logs.

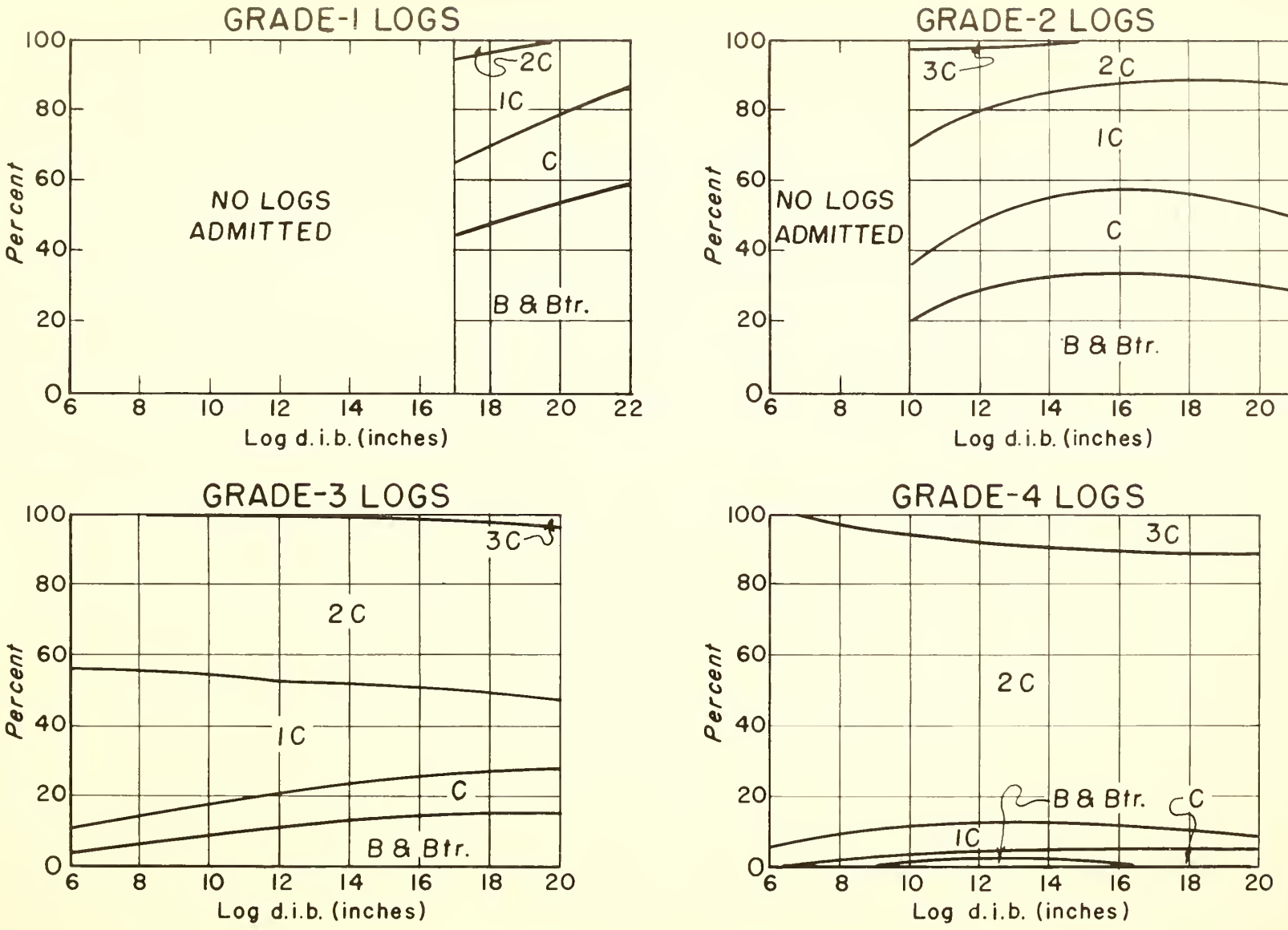
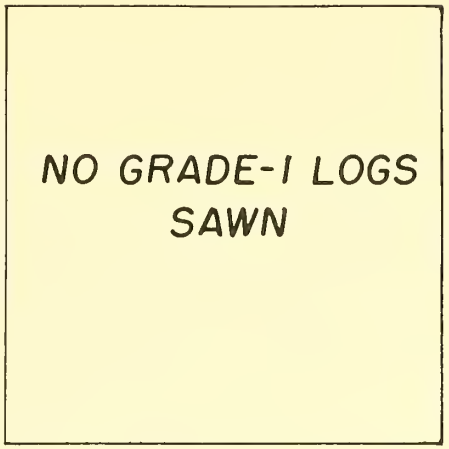
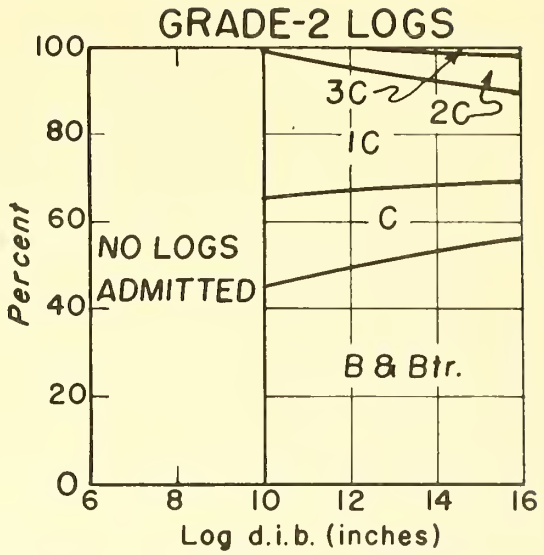
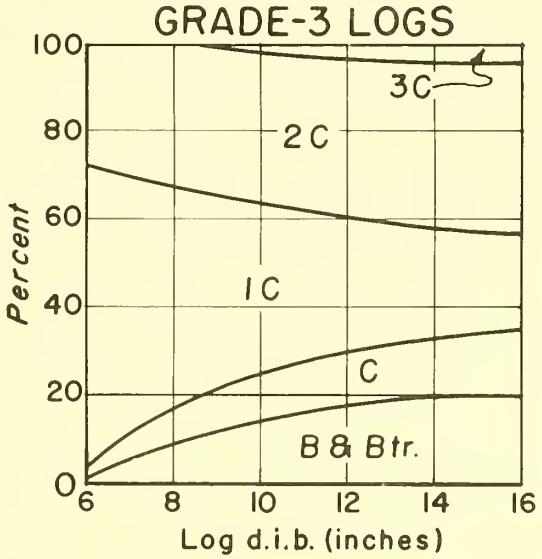


Figure 3.--Average percentage yard lumber grade recovery by log diameters and grades, loblolly-shortleaf pine type in the central Atlantic Coastal Plain near Charleston, S. C.







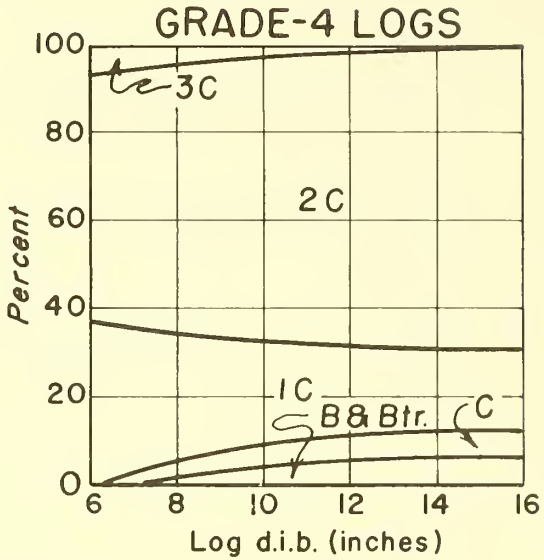


Figure 4.--Average percentage yard lumber grade recovery by log diameters and grades, loblolly-shortleaf pine type in the southern Piedmont near Macon, Ga.

Table 3.--Board width percentages of rough green lumber sawn from pine logs by circular mills

Log d.i.b. (inches)	Board width				
	4 in.	6 in.	8 in.	10 in.	12 in.
	- - - - - - Percent - - - - - -				
6	100	--	--	--	--
7	90	10	--	--	--
8	43	57	--	--	--
9	31	69	--	--	--
10	25	64	11	--	--
11	15	41	44	--	--
12	11	24	65	--	--
13	7	22	63	8	--
14	4	17	35	42	2
15	3	14	22	53	8
16	3	11	17	44	25
17	2	7	15	21	55
18	2	7	13	16	62
19	2	5	11	14	67
20	1	5	9	15	70
21	1	5	8	14	72
22	1	5	9	14	71

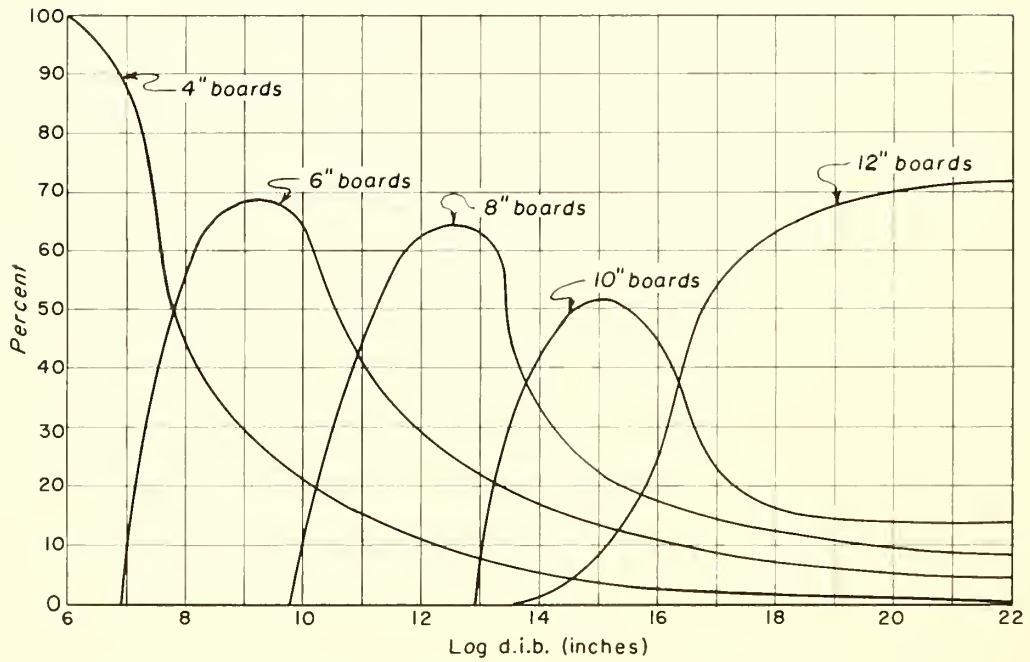


Figure 5.--Board width percentages of rough green lumber sawn from pine logs by circular mills.

Table 4.--Average log quality indices[1/] by log grade and diameter for shortleaf and loblolly pine, on a mill tally basis

Log d.i.b. (inches)	Atlantic Coastal Plain near Charleston, S. C.				Southern Piedmont near Macon, Ga.			
	Log grade				Log grade			
	1	2	3	4	1	2	3	4
	- - - - Index - - - -				- - - - Index - - - -			
6	--	--	125	98	--	--	134	113
7	--	--	128	100	--	--	136	115
8	--	--	130	102	--	--	139	116
9	--	--	132	103	--	--	141	118
10	--	160	135	104	--	179	143	119
11	--	165	138	106	--	184	146	120
12	--	170	140	107	--	189	148	122
13	--	176	142	108	--	194	151	123
14	--	181	145	110	--	200	153	125
15	--	186	147	111	--	205	156	126
16	--	192	150	112	--	210	158	127
17	230	197	152	114	--	--	--	--
18	236	202	154	115	--	--	--	--
19	242	207	156	116	--	--	--	--
20	249	212	159	117	--	--	--	--
21	255	218	--	--	--	--	--	--
22	262	223	--	--	--	--	--	--
Average	244	190	146	107		189	146	118

1/ In these indices the f.o.b. car price of No. 2 Common, standard length, 1 x 8, kiln dried, S4S boards has an index value of 100.

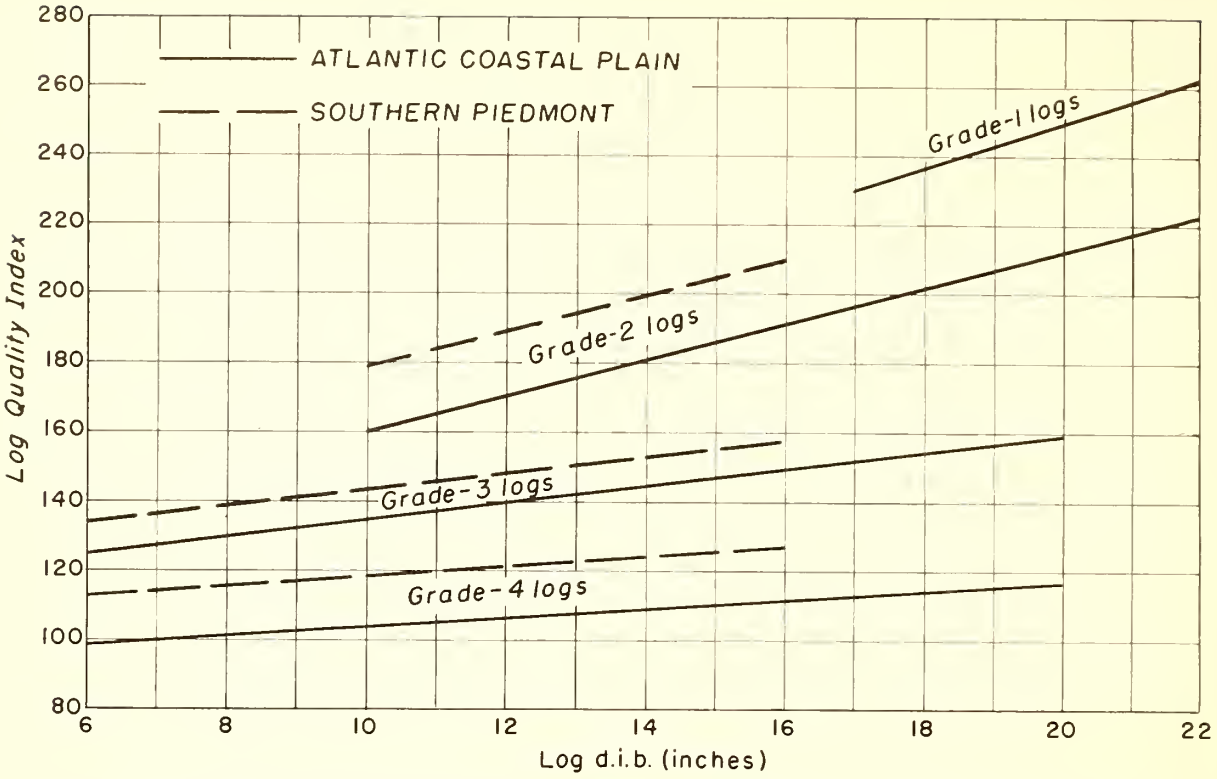


Figure 6.--Average log quality indices by log grade and diameter for shortleaf and loblolly pine, on a mill tally basis.

Log quality index may be converted from mill tally to gross or net log scale upon multiplying by the ratio mill tally ÷ log scale. These ratios should be determined by log grade separately and, depending on the log scale used, by log d.i.b. as well.

Upon deducting logging and milling costs and an appropriate margin for profit and risk, a fair appraisal of log worth per MBM log scale at any point in the conversion process can be determined.

TREE-GRADING SYSTEM NEEDED

Many foresters and timberland owners have indicated a need for a practical method by which the quality of a standing tree may be estimated. One obvious way would be to grade all the logs in the tree by the log grade specifications. A weighted average of the log quality indices would provide a tree quality index. Whether or not a simpler and yet sufficiently reliable method of tree grading is possible is still to be determined. Preliminary tests have shown that trees may be segregated into quality classes by log-grading the butt log only. This rests upon the assumption that the variation in log grade of the upper logs in a tree with a given butt-log grade does not seriously alter the quality estimate of the tree as a whole. It may prove desirable to reduce the effect of this upper log variation by associating total merchantable height and/or d.b.h. with the butt-log grade. With the investigation of a log grading system completed, research effort can now be directed toward the problem of tree grades.